

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
22 March 2001 (22.03.2001)

PCT

(10) International Publication Number  
**WO 01/20864 A1**

- (51) International Patent Classification<sup>7</sup>: H04L 27/26 (74) Agent: RODRIGUEZ, Michael, A.; Testa, Hurwitz & Thibeault, LLP, High Street Tower, 125 High Street, Boston, MA 02110 (US).
- (21) International Application Number: PCT/US00/25352 (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
- (22) International Filing Date: 15 September 2000 (15.09.2000) (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- (25) Filing Language: English (26) Publication Language: English
- (30) Priority Data:
- |            |                                |    |
|------------|--------------------------------|----|
| 60/154.116 | 15 September 1999 (15.09.1999) | US |
| 60/161.115 | 22 October 1999 (22.10.1999)   | US |
| 60/177.081 | 19 January 2000 (19.01.2000)   | US |
| 09/522.869 | 10 March 2000 (10.03.2000)     | US |

(71) Applicant: AWARE, INC. [US/US]; 40 Middlesex Turnpike, Bedford, MA 01730 (US).

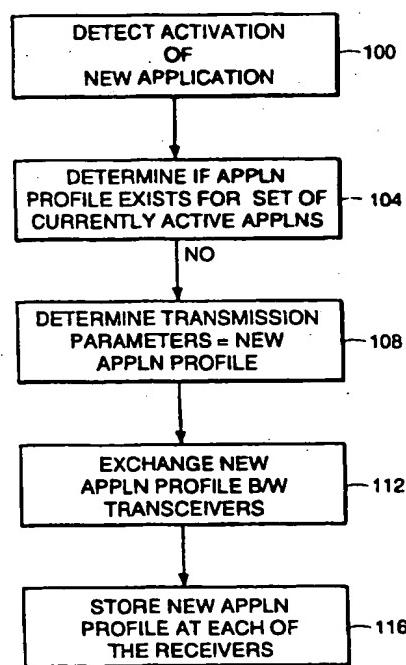
(72) Inventor: TZANNES, Marcos, C.; 121 La Espiral, Orinda, CA 94563 (US).

Published:

— With international search report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: MULTICARRIER SYSTEM WITH STORED APPLICATION PROFILES FOR SUPPORTING MULTIPLE APPLICATIONS



(57) Abstract: A system and method for supporting multiple applications are described. A digital subscriber line system includes two transceivers in communication over a communication channel using multicarrier modulation. Application profiles are defined for characterizing transmission of information over the communication channel. Each application profile is a parameter set that is associated with a unique set of one or more applications that may become active between the transceivers and specifies the transmission requirements for such applications. Each transceiver stores the application profiles and transmits information over the communication channel according to the one of the stored application profiles. When a change in a number of applications active between the transceivers occurs, a second one of the application profiles is retrieved. The transceivers then transition to transmitting information over the communication channel according to the second application profile. The transitioning can occur without interrupting communication between the transceivers in order to retrain the transceivers.

WO 01/20864 A1

MULTICARRIER SYSTEM WITH STORED APPLICATION PROFILES FOR SUPPORTING MULTIPLE APPLICATIONS

**Related Applications**

This application is a continuation-in-part of co-pending U.S. Patent Application Serial

- 5 No. 09/522,869, filed on March 10, 2000, which claims the benefit of and priority to U.S. provisional application Serial No. 60/124,222, filed March 12, 1999, entitled "Seamless Rate Adaptive (SRA) ADSL System", U.S. provisional application Serial No. 60/161,115, filed October 22, 1999, entitled "Multicarrier System with Stored Application Profiles", and U.S. provisional application Serial No. 60/177,081, filed January 19, 2000, entitled "Seamless Rate
- 10 Adaptive (SRA) Multicarrier Modulation System and Protocols. This application also claims the benefit of and priority to U.S. provisional application Serial No. 60/154,116, filed September 15, 1999, entitled "Transceiver Supporting Multiple Applications", U.S. provisional application Serial No. 60/161,115, filed October 22, 1999, entitled "Multicarrier System with Stored Application Profiles", and U.S. provisional application Serial No. 60/177,081, filed January 19,
- 15 2000, entitled "Seamless Rate Adaptive (SRA) Multicarrier Modulation System and Protocols, which co-pending provisional applications are incorporated herein by reference in their entirety.

**Field of the Invention**

This invention relates to transmission systems using multicarrier modulation. More particularly, the invention relates to multicarrier transmission systems that support multiple applications.

**Background**

In a conventional multicarrier transmission system, transceivers communicate over a communication channel using multicarrier modulation or Discrete Multitone Modulation (DMT). Carriers or subchannels spaced within a usable frequency band of the communication channel

- 2 -

are modulated at a symbol transmission rate of the system. In ADSL (Asynchronous Digital Subscriber Line) systems, the symbol rate is approximately 4 kHz. Every 250 microseconds, the transmitting transceiver allocates a new set of bits for transmission to the subchannels so that the bit error rates of the subchannels are substantially equal at the receiving transceiver.

- 5 Consequently, for a given symbol period the numbers of bits may vary from subchannel to subchannel.

ITU (International Telecommunication Union) standards G.992.1 and G.992.2 specify parameters that characterize the operation of ADSL DMT transceivers. Examples of parameters, to name but a few, include the data rate (b/s) for the connection between the transceivers, the 10 number of subchannels in the upstream and downstream directions, and the number of bits allocated to each subchannel. In general, such parameters remain fixed after the initial configuration and installation of the transceiver. Some parameters depend on the data rate of the connection and may change when the ADSL connection is at a high or low data rate. Some parameters may change when channel conditions change. However, after the type of application 15 is determined, i.e., voice, data, video, etc., the parameters are optimized and fixed for that application.

For splitterless operation, described in the ITU G.922.2 standard, ADSL transceivers store "channel profiles," which include a subset of parameters that are used when conditions of the communication channel change (e.g., a telephone goes off the hook). When the channel 20 conditions change because of an event that the ADSL transceiver does not control (e.g., a telephone connected to the same wire as the ADSL transceiver goes off hook), the ADSL transceiver must identify the new channel condition, retrain some of the receiver functions (e.g., equalizers, echo cancellers, etc.), and switch to the channel profile that is used for the new channel condition. This process, defined as a "Fast Retrain" procedure in ITU G.922.2, takes

- 3 -

approximately 1-2 seconds. These channel profiles, however, depend solely on the channel condition and not on the application(s) executing on the ADSL connection.

As technological advances increase the data rate throughput for multicarrier transmission systems, ADSL transceivers are becoming capable of supporting multiple applications. To support multiple applications, it is necessary that the ADSL transceiver be able to quickly and efficiently adapt the transmission parameters as the number and type of active applications change over time. For example, if the ADSL transceiver is accessing data over the Internet when a voice telephone call that is being transported over the ADSL connection becomes active, the ADSL transceiver must be able to modify the transmission parameters to accommodate both active applications. As other voice telephone calls and different applications (e.g., video on demand, video conferencing) become activated and deactivated over the ADSL connection, the ADSL transceiver must also be able to support the various transmission requirements of the various combinations of concurrently active applications. For example, video signals have higher reliability but lesser transmission delay requirements than voice and data signals. For some transmission systems, it has been necessary to find a compromise between high reliability and transmission delay.

Thus, there remains a need for a system and method that can support the various transmission requirements of multiple active applications as the number and type of active applications change over time.

20

#### Summary of the Invention

One objective is to provide a DMT transceiver that can support multiple applications and quickly and efficiently modify transmission parameters over time as applications are activated and deactivated. In one aspect of the invention, a multicarrier modulation system has two transceivers in communication with each other over a communication channel. In one aspect of the invention, a multicarrier modulation system has two transceivers in communication with each

- 4 -

other over a communication channel. The invention features a method for supporting a plurality of applications. A plurality of application profiles is defined. Each application profile corresponds to a unique set of one or more applications and specifies at least one transmission parameter for each application in that unique application set for transmitting information associated with that application over the communication channel.

The plurality of application profiles is stored at one of the transceivers. Information is transmitted according to a first stored application profile that corresponds to a set of currently active applications. A second stored application profile is selected in response to a change in the set of currently active applications. This second application profile corresponds to the one or 10 more applications in the changed set of currently active applications. The transmission of information transitions to the use of the second stored application profile, without interrupting communication between the transceivers in order to retrain the transceivers.

A message is transmitted to one of the transceivers, identifying the second application profile as the application profile to use for subsequent communications between the transceivers. 15 The message can operate to request a transition to the second application profile. Either a receiver or a transmitter of a transceiver can send the message to initiate the transition.

A reply message is received from the transceiver to which the message was transmitted. When the receiver sent the initial message, the reply message grants the request and synchronizes use of the second application profile. In one embodiment, an inverted sync symbol 20 is used for the reply message. When the transition is transmitter-initiated, the reply message grants the request to transition to the second application profile. Then, another message is sent, acknowledging the grant and synchronizing use of the second application profile. In one embodiment, this other message is an inverted sync symbol.

Each application profile can be transmitted to the other transceiver over the 25 communication channel with or without performing a full initialization of the transceivers.

- 5 -

Application profiles can be generated upon an initial occurrence of a unique set of active applications, and associated with that unique application set. In one embodiment, each of the transceivers locally generates at least one of the transmission parameters for one of the stored application profiles using a predefined process employed by both transceivers. In other 5 embodiments, transceivers can be preconfigured with the stored application profiles.

In an application profile, the transmission parameters specified for each application includes at least one of: a transmission data rate, subchannels allocated for downstream and upstream transmission, a number of bits allocated to each of the subchannels, performance margin, fine gain adjustments for each of the subchannels, interleave depth, a minimum and a 10 maximum QAM constellation size, a length of a cyclic prefix, a codeword size, a framing mode, and trellis code.

In another aspect, the invention features a method for supporting multiple applications that are active between the transceivers. A plurality of application profiles is developed for characterizing transmission of information over the communication channel. Each application 15 profile is associated with a unique set of one or more applications that may become active between the transceivers. The application profiles are stored at the transceivers. Information is transmitted over the communication channel according to a first stored application profile that corresponds to a set of currently active applications. A second one of the application profiles that corresponds to the changed set of currently active applications is retrieved in response to a 20 change in the set of currently active applications that are active between the transceivers. The transceivers transition to transmitting information over the communication channel according to the second application profile. The transitioning can occur with or without retraining the transceivers.

In still another aspect, the invention features a method for supporting a plurality of 25 applications in which a plurality of application profiles are defined. Each application profile

- 6 -

corresponds to a unique set of one or more applications and specifies at least one transmission parameter for each application in that unique application set for transmitting information associated with that application over the communication channel. The plurality of application profiles is stored at one of the transceivers.

5        In yet another aspect of the invention, a multicarrier modulation system has a transceiver communicating over a communication channel. A plurality of application profiles is defined. Each application profile corresponds to a unique set of one or more applications and specifies at least one transmission parameter for each application in that unique application set for transmitting information associated with that application over the communication channel.

10      The plurality of application profiles is stored at the transceiver. Information is transmitted according to a first stored application profile that corresponds to a set of currently active applications. A second stored application profile is selected in response to a change in the set of currently active applications. This second application profile corresponds to the one or more applications in the changed set of currently active applications. The transmission of information transitions to the use of the second stored application profile, without having to retrain the transceiver. The transceiver can transmit or receive a message that identifies the second application profile as the application profile to use for subsequent communications.

15      In still another aspect of the invention, each application profile corresponds to a unique set of one or more applications and specifies at least one reception parameter for each application in that unique application set, for receiving information associated with that application over the communication channel. The reception of information transitions from using the first stored application profile to use of the second stored application profile without having to retrain the transceiver. Again, the transceiver can transmit or receive a message that identifies the second application profile as the application profile to use for subsequent communications.

- 7 -

### Brief Description of the Drawings

The invention is pointed out with particularity in the appended claims. The advantages of the invention described above, as well as further advantages of the invention, may be better understood by reference to the following description taken in conjunction with the accompanying drawings, in which:

- Fig. 1 is a block diagram of an embodiment of a digital subscriber line multicarrier transmission system including a remote DMT (discrete multitone modulation) transceiver in communication with a central office transceiver and supporting multiple applications using application profiles in accordance with the principles of the invention;
- Fig. 2 is a block diagram of an embodiment of a transmitter of the remote DMT transceiver having two latency paths for supporting multiple applications with different latency requirements;
- Fig. 3 is a flow diagram of an embodiment of a process for initially exchanging and storing the application profiles at the central office and the remote DMT transceivers;
- Fig. 4 is a flow diagram of an embodiment of a receiver-initiated process used by the remote DMT transceiver and the CO transceiver to transition to a stored application profile; and
- Fig. 5 is a flow diagram of an embodiment of a transmitter-initiated process used by the remote DMT transceiver and the CO transceiver to transition to a stored application profile.

### Description of the Invention

- Fig. 1 shows an asymmetric DSL transmission system 2 including a remote discrete multitone modulation (DMT) transceiver 10 (e.g., a modem) in communication with a central office (CO) transceiver 14 over a communication channel 18. The remote DMT transceiver 10 includes a transmitter 22, a receiver 26, and memory 30 storing a plurality of application profiles (AP) 34 in accordance with the principles of the invention. The CO transceiver 14 includes a transmitter 38, a receiver 42, and memory 46 storing a plurality of application profiles 50 that

- 8 -

have a one-to-one correspondence with the application profiles 34 of the remote DMT transceiver 10.

The communication channel 18 in one embodiment is a pair of twisted wires of a telephone subscriber line. The communication channel 18 provides an upstream transmission path from the transmitter 22 of the remote DMT transceiver 10 to the receiver 42 of the CO transceiver 14, and a downstream transmission path from the transmitter 38 of the CO transceiver 14 to the receiver 26 of the remote DMT transceiver 10. The system 2 is asymmetric in that the bandwidth of the downstream transmission path is greater than the bandwidth of the upstream transmission path.

10       The remote DMT transceiver 10 and the CO transceiver 14 receive and transmit application streams 54, 54' (generally 54) using the application profiles 34, 50 in accordance with the principles of the invention. Each application stream 54 (hereafter, referred to as an application 54) conveys one type of signal (e.g., digital data, voice, video, etc.). For example, a stream of voice signals is one application, a stream of digital data signals is another application, 15 and a stream of video signals is yet another application. Voice applications correspond to one or more active voice telephone calls. An example of a digital data application are Internet access Web browsing (IAWB), and an example of a video application is video-on demand. The ADSL system 2 may also transmit applications 54 comprised of other signal types. Although shown as separate applications streams, the application streams can arrive at the transceiver 10, 14 as part 20 of a single stream of transmission packets (e.g., ATM cells) having the various types of signals.

      The ADSL system 2 supports multiple active applications 54 concurrently. For example, the transmitter 22 of the remote DMT transceiver 10 can concurrently transmit signals of a voice application and signals of a digital data application to the receiver 42 of the CO transceiver 14 over the upstream transmission path of the communication channel 18. As another example, Fig.

- 9 -

1 shows the ADSL system 2 concurrently transmitting signals associated with digital data, voice, and video applications 54 over the upstream and downstream transmission paths.

At any given point in time, the DSL system 2 has zero, one, or more applications 54 that are currently active. Each unique combination of one or more active applications, hereafter referred to as a set of applications or application set, represents an unique active communication state of the transceivers 10, 14. Examples of application sets 54 include: two or more concurrently active applications of different types (e.g., an Internet access Web browsing application together with a voice telephony application comprised of one or more voice telephone calls). Other examples of sets of active applications have only one active application (e.g., an Internet access Web browsing application, or one or more active voice telephone calls).

Each application 54 falls into one of two categories of applications: (1) fixed data rate applications, and (2) variable data rate applications. Fixed data rate applications require a specific bandwidth, and must obtain that bandwidth in order to pass over the communication channel 18. If the required data rate is presently unavailable, then the application is not presently supported. An example of a fixed data rate application is a voice telephony application that requires 64 kb/s for each active telephone call. Some video applications may also require a specific fixed data rate. Variable data rate applications can operate over a range of data rates (e.g., 1 Mb/s to 2 Mb/s). Thus, if the available channel bandwidth falls into this range, the application is supportable. An example of a variable data rate application is a digital data application (e.g., Internet access Web browsing). Some video applications are other examples of variable data rate applications that can operate within a data rate range.

Such data rate requirements determine, in part, the content of the application profiles 34, 50, as described in more detail below. In general, application profiles 34, 50 that support one or more fixed data rate applications specify the specific data rate requirement for each such fixed data rate application. Application profiles 34, 50 that support variable data rate applications

- 10 -

specify up to the maximum amount of available data rate that falls within the range of the particular variable data rate applications. Application profiles 34, 50 that support both fixed data rate and variable data rate applications first allot the specific data rate requirements to the specific fixed data rate application(s) and then allot the remaining available bandwidth to the  
5 variable data rate application(s).

Different types of applications 54 typically also have different transmission and reception requirements for reliability and transmission delay. More specifically, the requirements for data rate, latency, burst or impulse noise, bit error rate (BER), and data rate symmetry can vary significantly for different applications. For example, high-speed video applications are  
10 asymmetric, requiring a high downstream data rate, e.g., 1.5 Mb/s to 6 Mb/s, and a low upstream data rate, e.g., 16 kb/s to 64 kb/s. In addition, because video signals are highly compressed when transmitted, video applications have low immunity to impulse noise. Consequently, video applications require a low BER of <1E-9. A high latency of > 20 ms is acceptable.

In contrast, digital data applications, such as Web browsing over the Internet, are less  
15 asymmetric than video applications, using downstream data rates ranging between 32 kb/s to 6 Mb/s and upstream data rates between 32 kb/s to 1 Mb/s. Bit error rate requirements for digital data applications are <1E-7, generally being immune to impulse noise more than video applications. Also, a moderate latency of < 5 ms is generally acceptable.

Voice applications (i.e., telephone calls) are symmetric, requiring a 64 kb/s data rate in  
20 both the upstream and downstream transmission paths. Having a high immunity to impulse noise, voice applications can have a BER of <1E-3. In contrast to video and digital data applications, a low latency of approximately less than 1.5 ms is required.

Other types of applications may have other requirements.

Various digital multitone transmission (or reception) parameters control these  
25 requirements. For example, bit allocation tables (BAT) control the data rate and the bit error

- 11 -

rate. Reed-Solomon (R/S) coding controls and interleaving provides a lower bit error rate; both increase immunity to impulse noise at the expense of increased latency. The number of tones used in the upstream and downstream paths determines data rate symmetry. Consequently, a variety of parameters characterize the DMT transmission and reception of signals associated 5 with a given application 54 over the communication channel 18. (Hereafter, such parameters are referred to generally as transmission parameters although such parameters are also used in the reception of signals.) Such transmission parameters include:

- the data rate (in bits/second) for the given application (upstream and/or downstream) between the transceivers 10, 14;
- 10 the subchannels allocated in the upstream and downstream transmission paths for the given application;
- the number of bits allocated to each subchannel for the given application;
- the minimum and maximum quadrature amplitude modulation (QAM) constellation size used on each subchannel for the given application;
- 15 the inclusion or exclusion of a trellis code for the given application;
- the length of the cyclic prefix for the given application;
- coding parameters (e.g., R/S codeword size) for the given application;
- the interleaver depth, if an interleaver is used for the given application;
- the framing mode (e.g., the ITU ADSL transmission standards G.922.1 specify four 20 different framing modes) for the given application;
- the fine gain adjustments made to each tone for the given application; and
- the performance margin for the given application.

To transmit and receive signals associated with one or more active applications, the remote DMT transceiver 10 and the CO transceiver 14 use the application profiles 34, 50 to 25 characterize such communications. More specifically, each application profile 34, 50 is a

- 12 -

parameter set that specifies the transmission parameters for a unique set of one or more presently active applications 54. Application profiles corresponding to application sets that represent only one active application specify the transmission parameters for that one application. As described below, the values assigned to the parameters of each application profile 34, 50 depend upon the 5 category and type of each application in the application set corresponding to that application profile.

For application sets that represent two or more concurrently active applications, the corresponding application profile 34, 50 specifies transmission parameters that concurrently accommodate every active application in that application set. In effect, the application profile 10 34, 50 operates to combine the individual transmission (or reception) requirements of the individual applications 54 into a single transmission parameter set that achieves concurrent transmission of every active application.

For example, assume that the total data rate of a connection is 1.532 Mb/s. When a variable data rate application (e.g., a digital data application) is running alone, it uses the full 15 available data rate of 1.532 Mb/s, presuming that this data rate is within the range of data rates for the variable data rate application. Thus, one embodiment of the application profile, corresponding to this variable data rate application, allots the full available data rate of the connection to the variable data rate application. When a fixed data rate application (e.g., voice application) is running alone, it uses the specifically required data rate (e.g., a 64 kb/s data rate 20 for a voice application). Thus, one embodiment of the application profile, corresponding to this fixed data rate application, allots the specifically required data rate to the fixed data rate application.

When the above-described fixed and variable data rate applications run concurrently, the application profile corresponding to this set of two applications provides first for the data rate 25 requirements of the fixed data rate application and then for the variable data rate application.

- 13 -

using the channel bandwidth that remains after satisfying the fixed data rate application. Thus, if the fixed data rate application is a voice application requiring 64 Kb/s, the application profile specifies the required 64 Kb/s for the voice application and allots the remaining channel bandwidth of 1.468 Mb/s data rate to the variable data rate application. As another example, if 5 the fixed data rate application is a voice application comprised of two voice calls, each requiring 64 Kb/s, the application profile specifies the required 128 Kb/s for the voice application and gives the remaining channel bandwidth of 1.404 Mb/s data rate to the variable data rate application. In these examples, it is presumed that the reduced bandwidth for the variable data rate application (i.e., from 1.532 Mb/s to 1.468 Mb/s or 1.404 Mb/s) falls within the range of 10 acceptable data rates of the variable data rate application. In effect, the parameters associated with transmitting and receiving signals for each of the active applications individually are combined within the application profile in a manner that achieves the simultaneous transmission and reception of signals for all of the concurrently active applications.

Although shown above to specify the data rate for particular applications, each 15 application profile 34, 50 may specify one or any combination of the parameters described above and other unlisted parameters for characterizing the DMT transmission (and reception) of signals associated with each application in that application profile. For example, other transmission parameters that the application profile 34, 50 can specify are the number of latency paths required to support the applications in the application profile, and the data rate of each latency 20 path.

As another example, application profiles can also specify the allocation of subchannels to applications. For example, assume that when a variable data rate application is running alone, the corresponding application profile allocates every available subchannel to carry bits associated with the variable data rate application. Further assume that when a fixed data rate 25 application is running alone, the corresponding application profile allocates a subset of the

- 14 -

available subchannels sufficient to achieve the specifically required data rate (e.g., a 64 kb/s data rate for a voice application) of the fixed data rate application. When these fixed and variable data rate applications run concurrently, the application profile corresponding to this set of two applications specifies the allocation of some subchannels to the fixed data rate application, and 5 other subchannels to the variable data rate application. Possibly, one or more of the subchannels are allocated to both the fixed and variable data rate applications.

Application profiles are further illustrated by the following five examples of application profiles, AP #1 - AP #5, which can be developed and stored at the transceivers 10, 14. These exemplary profiles specify the transmission characteristics for five different communication 10 states involving two types of applications, a fixed data rate voice application comprised of one or more voice calls and a variable data rate Internet access Web browsing (IAWB) application. For these examples, assume that the total data rate of the connection (e.g., upstream) between the transceiver 10, 14 is 1.532 Mb/s, and that the IAWB application has a minimum and maximum data rate range of 1 Mb/s to 2 Mb/s. Each voice call of the voice application requires 64 kp/s. In 15 general, the fixed data rate applications receive the data rate that each requires, and the variable data rate receives the balance of the bandwidth capacity of the connection.

#### **Application Profile #1**

Application profile #1 (hereafter, also AP #1) corresponds to an application set of only one variable data rate application, the IAWB application with the data rate range of 1 Mb/s and 2 20 Mb/s. Thus, AP #1 specifies the full connection capacity (here, 1.532 Mb/s) for transmitting signals associated with the IAWB application. All useable subchannels are allocated to the IAWB data stream with a 1E-7 BER on each subchannel. An R-S codeword size is 200 bytes with interleaver depth of 5 codewords.

- 15 -

#### **Application Profile #2**

Application profile #2 (hereafter, also AP #2) corresponds to an application set of only one fixed data rate application, a voice telephone (VT) application requiring 64 kb/s. Thus, AP #2 specifies 64 kp/s for transmitting signals associated with the VT application. A subset of 5 the subchannels sufficient to achieve 64 kb/s is allocated to the VT data stream with a 1E-3 BER on each subchannel. There is no coding or interleaving.

#### **Application Profile #3**

Application profile #3 (hereafter, also AP #3) corresponds to an application set of only one fixed data rate application, specifically, one voice application comprised of two voice 10 telephone (VT) calls on separate voice channels, each call requiring 64 kb/s. Accordingly, AP #3 specifies a data rate of 128 kb/s (i.e., 2 x 64 kb/s) for transmitting signals associated with this VT application. A subset of the subchannels sufficient to achieve 128 kb/s is allocated to the VT data stream with a 1E-3 BER on each subchannel. Again, there is no coding or interleaving.

#### **Application Profile #4**

15 Application profile #4 (hereafter, also AP #4) corresponds to an application set of two applications of different types, specifically, the variable data rate IAWB application and one fixed data rate VT application. For transmitting signals associated with the IAWB and VT applications, AP #4 specifies the data rate for the VT stream as 64 kb/s and for the IAWB stream as 1.468 Mb/s (1532 kb/s - 64 kb/s). A subset of the subchannels sufficient to achieve 64 kb/s is 20 allocated to the VT stream with a 1E-3 BER on each subchannel so allocated. A subset of the subchannels sufficient to achieve 1.468 Mb/s is allocated to the IAWB stream with 1E-7 BER on each subchannel so allocated. For the IAWB stream, there is an R-S codeword size of 200 bytes with an interleaver depth of 5 codewords; for the VT stream, there is no coding or interleaving.

- 16 -

### Application Profile #5

Application profile #5 (hereafter, also AP #5) corresponds to an application set of two applications; the variable data rate IAWB application and one fixed data rate VT application comprised of two voice telephone calls on separate channels, each call requiring 64 kb/s. For 5 transmitting signals associated with the IAWB and the VT applications, AP #5 allots a 128 kb/s data rate for the VT stream and a 1.404 Mb/s (1532 kb/s - 128 kb/s) data rate for the IAWB stream. A subset of the subchannels sufficient to achieve 128 kb/s is allocated to the VT data stream with a 1E-3 BER on each subchannel so allocated. A subset of the subchannels sufficient to achieve 1.404 Mb/s is allocated to the IAWB stream with 1E-7 BER on each subchannel so 10 allocated. For the IAWB stream, there is an R-S codeword size of 200 bytes with an interleaver depth of 5 codewords; again, for the VT stream, there is no coding or interleaving.

As applications 54 become active and inactive over time, the remote DMT transceiver 10 and the CO transceiver 14 use the stored application profiles 34, 50 to change the transmission parameters quickly and efficiently and thereby accommodate the transmission requirements of 15 the currently active application(s). Whenever a change occurs to the set of currently active applications, the remote DMT transceiver 10 and CO transceiver 14 select the appropriate application profile from the stored set of profiles 34, 50. In one embodiment, if an application profile does not yet exist for the current set of active applications, one of the transceivers 10, 14 generates the appropriate application profile and exchanges that new application profile with the 20 other transceiver over the communication channel 18. In other embodiments the transceivers 10, 14 can be configured with predefined application profiles and/or dynamically generate application profiles during the operation of the ADSL system 2 as the need for such profiles arises. In another embodiment, the transmission parameters in the application profiles are exchanged during initialization. In yet another embodiment, transmission parameters in the 25 application profiles are mutually generated by each transceiver 10, 14 locally.

- 17 -

Fig. 2 shows an exemplary embodiment of the transmitter 22 of the remote DMT transceiver 10 including two latency paths 56, 58 for supporting multiple applications 54 with different latency requirements. The transmitter 38 of the CO transceiver 14 comprises equivalent paths and functions as the transmitter 22. The receivers 26, 42 also comprise 5 equivalent latency paths, but in reverse order and performing inverse operations than those of the transmitters 22, 38 to demodulate the information received over the communication channel 18.

The multiple latency paths 56, 58 are used to send different application bit streams with different latency requirements through the ADSL DMT transceiver 10. In Fig. 2, two different applications 54'', 54''' are shown. One exemplary application 54'' is a digital data stream (e.g., 10 and ATM (asynchronous transfer mode) data stream) and the other exemplary application is a voice telephony application. It is to be understood that additional and/or different applications can be used, and that the use of the digital data and voice telephony applications is merely 15 illustrative of the principles of the invention. The digital data application 54'' can tolerate a moderate amount of latency (i.e., less than approximately 5 ms) and is sent through the latency path 56, which has interleaving. The voice telephony application 54''' with low latency requirements is sent through the other latency path 58, which has no interleaving.

The transmitter 22 can have additional and/or different latency paths. For example, in one embodiment, the ADSL system 2 has a video application in addition to the digital data and voice telephony applications. This video application can tolerate a higher latency than the 20 moderate latency of the ATM data application 54'' and the low latency of the voice telephony application 54'''. For this embodiment, the ADSL system 2 can accommodate the latency requirements of the video application by providing a third, different latency path.

Each latency path 56, 58 includes three blocks: a MUX block 60, a framer/coder/interleaver (FCI) block layer 64, 64', and a modulator block 68. The MUX block 25 60 has multiple inputs for receiving the signal streams of the active applications 54 and an output

- 18 -

for each latency path 56, 58. The MUX block 60 directs the signal stream of the digital data application 54'' to the first latency path 56 and the signal stream of the voice data application 54''' to the second latency path 58.

Each FCI block 64, 64' (generally 64) provides functionality associated with preparing a stream of bits for modulation, transforming the received signals into frames and superframes, adding overhead channel (i.e., AOC and EOC) information the frames, and if applicable, coding and interleaving. The operations performed by each FCI block 64 depends upon the type of application 54'', 54''' and the latency path 56, 58 taken by that application.

On the first latency path 56, the FCI block 64 includes a framer block 72, a cyclic redundancy check (CRC) and scrambler (SCR) block 76, a forward error correction (FEC) block 80 (e.g., R-S Coding), and an interleaving (INT) block 84. On the second latency path 58, the FCI block 64' includes a framer block 76' and a CRC and SCR block 80'. The second latency path 58 through the FCI block 64' has a different (i.e., lesser) amount of latency than the first path 56 because the second path 58 does not perform interleaving or coding on the voice stream.

The modulator block 68 provides functionality associated with DMT modulation and includes a quadrature amplitude modulation (QAM) encoder 88 and an inverse Fast Fourier transform (IFFT) 92. The QAM encoder 88 has multiple inputs to receive and combine the signal streams from the latency paths 56, 58 into a single signal stream that is sent to the IFFT 92 for modulation. The IFFT 92 modulates bits received from the QAM encoder 88 into the multicarrier subchannels of the communication channel 18.

Also shown in Fig. 2 are the five exemplary application profiles, AP #1 - AP #5, which are described in Fig. 1. Application profiles #1, #4, and #5 are in communication with the FCI block 64 of the first latency path 54 because each of these profiles specifies one or more transmission parameters that characterizes the ATM data stream. Application profiles #2, #3, #4, and #5 are in communication with the FCI block 64' of the second latency path 58 because each

- 19 -

of these profiles specifies one or more transmission parameters that characterize the voice stream. In one embodiment, all five of the application profiles, AP #1-AP #5, are in communication with the Modulator block 68 because each profile specifies one or more transmission parameters that characterize the allocation of bits to subchannels of the 5 communication channel 18.

### **Storing and Exchanging Application Profiles**

#### **Predefined profiles**

Before the transceivers 10, 14 can communicate over the communication channel 18 using an application profile to characterize such communications, that application profile is 10 stored in the appropriate local memory 30, 46. In one embodiment, each transceiver 10, 14 is preconfigured (e.g., factory set); that is, the application profile is already stored in the local memory 30, 46 before the transceivers 10, 14 are incorporated into the ADSL system 2.

#### **Profiles exchanged and stored upon first occurrence of an application set**

In another embodiment, the transceivers 10, 14 exchange the application profile over the 15 communication channel 18 and then store the application profile. Fig. 3 shows an embodiment of a process used to accomplish the profile exchange. For the purpose of illustrating the process, assume that the remote DMT and CO transceivers 10, 14 are exchanging signals associated with an Internet access Web browsing (IAWB) application according to the AP #1 of Fig. 1, when a new voice application becomes activated, resulting in the need of a new application profile. In 20 general, either the remote DMT transceiver 10 or the CO transceiver 14 can act as the initiator of an exchange of the new application profile. More specifically, either the transmitter 22 or the receiver 26 of the remote DMT transceiver 10, or the transmitter 38 or the receiver 42 of the CO transceiver 14 can initiate the new application profile exchange.

During the exchange of IAWB signals, the activation of the new voice application 54 is 25 detected (step 100). Either transceiver 10, 14 or other component of the DSL system 2 (e.g., a

- 20 -

computer system within which the transceiver 10, 14 operates) may make this detection. Upon the detection of this new voice application 54, a determination is made (step 104) as to whether an application profile for the combination of the active IAWB application and the new voice application already exists. Again, the transceiver 10, 14 or another component of the DSL 5 system 2 may make this determination. When such an application profile does not exist, transmission parameters are determined (step 108) that accommodate the concurrent transmission of signals associated with the IAWB application and the new voice application. Note that the deactivation of an active application can also result in a unique set of currently active applications for which there does not presently exist an application profile. In such an 10 event, transmission parameters are likewise determined (step 108) for transmitting signals associated with the one or more applications that are currently active after the deactivation.

These transmission parameters represent a new application profile. One embodiment of this new application profile can be application profile #4 (AP #4), as described above Fig. 1, because AP #4 supports one IAWB application and one voice application. An identifier is 15 associated with the new application profile. For example, if at the time of activation of this new application there are already three stored application profiles, the new application profile becomes the fourth. Because of the one-to-one correspondences between application profiles at the CO transceiver 14 as those at the remote DMT transceiver 10, the same identifier is to be used by the remote DMT 10 and CO transceivers 14 to identify the new application profile.

20 One of the transceivers 10, 14 then exchanges the new application profile with the other transceiver 14, 10, sending (step 112) the transmission parameters associated with the new application profile over the communication channel 18 using the AOC or EOC channel. In one embodiment, transmission of this new application profile operates as a message requesting use of the new application profile.

- 21 -

#### Profiles exchanged and stored during Full initialization

In another embodiment, the transceivers 10, 14 exchange the new application profile with each other using the ITU compliant "Full Initialization" protocol of the G.992.2 or G.992.1 ITU standards, or a similar initialization protocol that interrupts the application data communication between the transceivers 10, 14 in order to train and exchange transmission information between transceivers. Use of the Full Initialization protocol causes approximately a 10-second drop in the link. This 10-second interruption occurs only once, upon the first occurrence of a unique set of currently active applications for which a new application profile is exchanged and subsequently stored. In another embodiment, upon initialization the transceivers 10, 14 negotiate the application to be supported and exchange profiles corresponding to all possible combinations of active applications.

After the application profile is exchanged, the transceivers 10, 14 store (steps 116) the application profile in local memory, 30, 46. Consequently, when a new voice application is activated while the transceivers 10, 14 are communicating according to AP #1 (Fig. 1), the transition to the stored AP #4 (Fig. 1) occurs quickly, as described in more detail below, because the exchange of the application profile over the communication channel 18 is not performed; the exchange is unnecessary.

#### Locally generating parameters in an application profile

In the exchange of the new application profile between transceivers 10, 14, the transceivers 10, 14 do not need to exchange every transmission parameter of the new application profile over the communication channel 18. In one embodiment, the each transceiver 10, 14 can locally develop one or more transmission parameters (e.g., the allocation of subchannels to applications) and store the locally developed parameter in the appropriate application profile. The local development of such transmission parameters can occur when initially developing or updating an application profile.

- 22 -

For example, assume that the transceivers 10, 14 are running two applications: a digital data application and a voice application. The transceivers 10, 14 exchange information with each other indicating that the connection supports these two applications. Based on the exchange of this information, each transceiver 10, 14 locally generates one or more transmission parameters for the application profile that corresponds to the two applications. Because both transceivers 10, 14 mutually generate these transmission parameters, the transceivers 10, 14 do not exchange the locally generated transmission parameters with each other over the communication channel 18. Other transmission parameters, such as those associated with framing, coding, and interleaving, are still determined in the information exchange between the transceivers 10, 14.

Mutually generating transmission parameters has the advantage of reducing or eliminating lengthy exchange messages when initially developing or updating an application profile. For example, if changes in channel conditions result in a decrease in the total data rate of the channel 18, resulting in a lower bit capacity for some of the subchannels, then typically, the transceivers 10, 14 would need to exchange updates with each other for all application profiles that specify those affected subchannels. By mutually generating transmission parameters in the application profiles, the transceivers 10, 14 can each locally update the application profiles without having to exchange the update information with each other.

The following three examples illustrate the use of mutually generated parameters as applied to the allocation of subchannels to two applications, here a digital data application and a voice application. Each example shows an application profile that specifies the allocation of subchannels to the applications as a transmission parameter: (1) one application profile for when the digital data application runs alone, (2) another for when the voice application runs alone, and (3) another for when the digital data and voice applications run concurrently.

- 23 -

For the first application profile, the transceivers 10, 14 each locally allocate all of the available data rate and useable subchannels to the digital data application after establishing the connection. Other transmission parameters that are not mutually generated by the transceivers 10, 14, e.g., those parameters associated with framing, coding, and interleaving, are determined 5 in the information exchange between the transceivers 10, 14.

For the second application profile, the transceivers 10, 14 allocate 64 kb/s to the voice application, regardless of the data rate capability of the connection. Each transceiver 10, 14 uses a predetermined technique (e.g., specified by a standard) to select the subchannels that are allocated to carry the 64 kb/s of the voice application. Examples of schemes that iterate through 10 the available subchannels to select subchannels for the voice application include: (1) ascending from a subchannel with the lowest frequency to subchannels with higher frequencies; (2) descending from an available subchannel with the highest frequency to subchannels of lower frequencies; (3) ascending from a subchannel with the least number of bits to subchannels with higher numbers of bits; and (4) descending from a subchannel with the most number of bits to 15 subchannels with lesser numbers of bits. Again, the transceivers 10, 14 can frame, code, and interleave in a predefined manner or as determined during the exchange during initialization.

For the third application profile, each transceiver 10, 14 allocates 64 kb/s to the voice application and the remaining data rate to the digital data application. Similar to the second application profile, each transceiver 10, 14 uses a predetermined technique for choosing the 20 subchannels that are allocated to carry the voice application (e.g., subchannels of the highest or lowest frequency or of the smallest or largest constellations). Also, framing, coding, and interleaving are predefined or determined during the exchange as described above.

The transceivers 10, 14 use a coordinated numbering scheme for the locally generated application profiles (e.g., #6 = digital data application only, #7 = voice application only, #8 =

- 24 -

digital data and voice applications together). The numbering scheme can be predefined or the transceivers 10, 14 can exchange the numbering scheme over the communication channel 18.

The principles of the invention extend to embodiments with more than the two applications. For such embodiments, to generate corresponding application profiles for each of 5 the possible active applications, individually and in combination, the transceivers 10, 14 follow prescribed rules for selecting the application profile transmission parameters and their corresponding parameter values.

#### **Fast Transitioning to a Stored Application Profile**

Throughout the operation of the DSL system 2, applications may be activated and de-  
activated over time. This change in the active applications (i.e., via the activation or deactivation  
of an application) is known by the transceiver 10 (or receiver) and therefore does not need to be  
identified with a Fast Retrain as specified in the ITU G.922.1 and G.922.2 standards. Since the  
application profile is being changed because of a change in the active applications, and not  
because of a change in the channel conditions, there is no requirement to retrain retriever  
functions, such as echo cancellars, equalizers, etc., as is done in a Fast Retrain.  
15

Storing application profiles for subsequent use shortens the handshake between the  
transceivers 10, 14, used by the transceivers 10, 14 to transition to another application profile  
because the transceivers do not have to undergo the process of creating, exchanging, and storing  
a new application profile.

20 The remote DMT transceiver 10 or the CO transceiver 14, and either the receiver or the transmitter of that transceiver 10, 14 can initiate the transition. Stored application profiles are identified so that the transmitter and the receiver simply notify the other as to which profile is to be used. The information associated with the application profile does not have to be transmitted again. In one embodiment, the stored application profiles are numbered. Accordingly, one  
25 transceiver simply specifies the number of the desired application profile to the other transceiver.

- 25 -

### Receiver-Initiated Fast Application Profile Transition

Fig. 4 shows an embodiment of a receiver-initiated process used by the remote DMT transceiver 10 and the CO transceiver 14 to transition to a stored application profile. Although the process is shown from the perspective of the receiver 26 of the remote DMT transceiver 10, 5 it is to be understood that the receiver 42 of the CO transceiver 14 can also initiate the transition. In one embodiment, a change in the set of currently active applications occurs (step 140), requiring a transition to another application profile. The change may be the result of an application that has been activated or deactivated, or of an existing application that requires additional bandwidth (e.g., a second voice channel opens for a voice application that previously 10 had only one voice channel).

After the change in the active applications, the receiver 26 determines (step 142) which application profile corresponds to the current set of active applications. The receiver 26 sends (step 148) a message to the transmitter 38 using the AOC or EOC channel specifying the stored application profile that is to be used for transmission based on this current set of active 15 applications. This message corresponds to a request by the receiver 26. For example, if the transceivers 10, 14 are communicating according to AP #1 (Fig. 1) when a voice telephone call is activated, the receiver 26 sends the request to the transmitter 38 requesting a transition to AP #4 (Fig. 1). In one embodiment, the request identifies the AP #4 by the numeral 4.

After receiving the request, the transmitter 38 sends (step 152) an inverted sync symbol 20 as a flag to signal the receiver 26 that the requested stored application profile is about to be used for transmission and to synchronize its use. The transmitter 38 uses (step 154) its stored copy of the specified application profile for transmission on the first frame, or on a predetermined number of frames, following the inverted sync symbol. This inverted sync signal corresponds to a "Go" message sent by the transmitter 38. The receiver 26 detects (step 156) the inverted sync 25 symbol and, in synchronization with the transmitter 38, uses the specified application profile

- 26 -

upon the first frame, or the predetermined number of frames, received after the inverted sync symbol.

The inverted sync symbol is a sync symbol in which the phase information in the QAM signal is shifted by 180 degrees. Phase shifts of the sync symbol other than 180 degrees can also 5 be used for the "Go" message. The sync symbol is defined in the ANSI and ITU standards as a fixed non-data carrying DMT symbol that is transmitted every 69 symbols. The sync symbol is constructed by modulating all the DMT carriers with a predefined pseudo-random number sequence using basic QPSK (2 bit QAM) modulation. This sync symbol signal, which is used throughout the transceiver initialization process, has special autocorrelation properties that make 10 possible the detection of the sync symbol and the inverted sync symbol even in highly noisy environments.

Because of its near invulnerability to channel noise, use of the inverted sync symbol to synchronize use of the new application profile by the transceivers 10,14 is more robust than using the EOC or AOC channel. In contrast, messages sent over the EOC or AOC channel can 15 be more easily corrupted by noise on the communication channel 18 than the inverted sync symbol. These overhead channels are multiplexed into the data stream at the framer 72 and therefore are transmitted with quadrature amplitude modulation over a finite number of DMT subchannels. Impulse noise or other noise occurring on the communication channel 18 can cause bit errors in the EOC or AOC channel message, causing the message to be lost. Notwithstanding 20 this sensitivity of the EOC or AOC channel to noise, which is greater than that of the inverted sync symbol, in one embodiment the EOC or AOC channel is used to communicate the "Go" message.

Receiver-initiated transitioning to a stored application profile completes quickly, requiring the exchange of only two messages (the request and the "Go" message) because the 25 appropriate application profile is stored and does not need to be exchanged. Again, use of the

- 27 -

inverted sync symbol as the "Go" message makes the synchronization between the transceivers 10, 14 robust in noisy environments.

#### **Transmitter-initiated Fast Application Profile Transition**

Fig. 5 shows an embodiment of a transmitter-initiated process used by the remote DMT transceiver 10 and the CO transceiver 14 to transition to a stored application profile. Although the process is shown from the perspective of the transmitter 22 of the remote DMT transceiver 10, it is to be understood that the transmitter 38 of the CO transceiver 14 can also initiate the transition. As before, a change in the set of currently active applications occurs (step 160), requiring a transition to another application profile. Again, the change may be the result of an application that has been activated or deactivated, or of an existing application that requires additional bandwidth (e.g., a second voice channel opens for a voice application that previously had only one voice channel).

After the change in active applications, the transmitter 22 determines (step 162) which application profile corresponds to the current set of applications. The transmitter 22 sends (step 168) a message to the receiver 42 using the AOC or EOC channel specifying the stored application profile that is to be used for transmission based on the current set of active applications. The message can identify the appropriate stored application profile by number or by any other identification uniquely associated with that stored application profile. This message corresponds to a request by the transmitter 22. After receiving the request, the receiver 42 returns (step 172) a "grant" or "deny" message to the transmitter 22.

If the transmitter 22 receives the "grant" message, the transmitter 22 sends (step 176) an inverted sync symbol as a flag to signal the receiver 42 that the requested stored application profile will be used for transmission. The transmitter 22 then uses (step 178) its stored copy of the specified application profile for transmission on the first frame, or a predetermined number 25 of frames, following the inverted sync symbol. The inverted sync signal corresponds to a "Go"

- 28 -

message sent by the transmitter 22. The receiver 42 detects (step 180) the inverted sync symbol (“Go”) and starts communicating using the specified application profile for reception on the first frame, or a predetermined number of frames, following the inverted sync symbol in synchronization with the transmitter 22.

- 5       Transmitter-initiated transitions to a stored application profile completes quickly, requiring the exchange of three messages (the request, the deny or grant message, and the Go message) when transmitter-initiated, because the appropriate application profile is stored and does not need to be exchanged. Again, use of the inverted sync symbol as the “Go” message makes the synchronization between the transceivers 10, 14 robust in noisy environments.
- 10      In another embodiment, the transceivers 10, 14 transition to a stored application profile using the “Fast Retrain” protocol described in the ITU G.922.2 specification, or a similar fast initialization protocol that interrupts the application data communication between the transceivers 10, 14 in order to train and exchange transmission information between transceivers. The Fast Retrain causes a 1 to 2 second disconnection between the transceivers 10, 14.

15      **Updating Application Profiles**

Under certain circumstances, the contents of a stored application profile 34 (and the corresponding application profile 50) may require updating. For example, communication channel 18 conditions can change, (e.g., a telephone goes off the hook), which result in an increase or decrease in the data rate capabilities of the channel 18 and a different bit capacity of 20 certain subchannels of the channel 18. The transceivers 10, 14 then need to update all stored application profiles that specify the bit capacity of the affected subchannels. In one embodiment, each transceiver 10, 14 locally updates its own stored copy of the affected application profile without exchanging the update information with each other. In another embodiment, the transceivers 10, 14 exchange the update information with each other.

- 29 -

While the invention has been shown and described with reference to specific preferred embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the following claims. For example, although the invention is described with respect to DMT modulation, the principles of the invention also apply to DWMT (Discrete Wavelet Multitone) modulation. Also, IP frames instead of ATM packets can be used to transport data. Further, although the specification uses ADSL to describe the invention, it is to be understood that any form of DSL can be used, i.e., VDSL, SDSL, HDSL, HDSL2, or SHDSL. The principles of the invention also apply to any DMT communication system that supports multiple sets of applications, where the applications are activated and de-activated over time. Although several embodiments described above included Internet and voice applications, it is also to be understood that the principles of the invention apply to any combination of applications transported over DSL systems (e.g., telecommuting, video conferencing, high speed Internet access, video-on demand).

- 30 -

What is claimed is:

1. 1. In a multicarrier modulation system including two transceivers in communication with each other over a communication channel, a method for supporting a plurality of applications comprising:
  4. defining a plurality of application profiles, each application profile corresponding to a unique set of one or more applications and specifying at least one transmission parameter for each application in that unique application set for transmitting information associated with that application over the communication channel;
  5. storing the plurality of application profiles at one of the transceivers;
  6. transmitting information according to a first stored application profile that corresponds to a set of currently active applications;
  7. selecting, in response to a change in the set of currently active applications, a second stored application profile that corresponds to the one or more applications in the changed set of currently active applications; and
  8. transitioning to transmitting information according to the second stored application profile, without interrupting communication between the transceivers in order to retrain the transceivers.
1. 2. The method of claim 1 further comprising receiving a message that identifies the second application profile as the application profile to use for subsequent communications.
1. 3. The method of claim 1 further comprising transmitting a message to one of the transceivers that identifies the second application profile as the application profile to use for subsequent communications between the transceivers.
1. 4. The method of claim 1 further comprising transmitting a message to one of the transceivers requesting a transition to the second application profile.

- 31 -

- 1 5. The method of claim 4 further comprising receiving a reply message from that one
  - 2 transceiver, granting the request to transition to the second application profile.
  - 1 6. The method of claim 5 further comprising sending another message to that one
  - 2 transceiver, acknowledging the grant and synchronizing use of the second application
  - 3 profile.
  - 1 7. The method of claim 5 wherein the other message is an inverted sync symbol.
  - 1 8. The method of claim 4 further comprising receiving a reply message from that one
  - 2 transceiver, granting the request and synchronizing use of the second application profile.
  - 1 9. The method of claim 8 wherein the reply message is an inverted sync symbol.
  - 1 10. The method of claim 1 further comprising transmitting at least one of the application
  - 2 profiles to the other transceiver over the communication channel without performing a
  - 3 full initialization of the transceivers.
  - 1 11. The method of claim 1 further comprising performing a full initialization of the
  - 2 transceivers to exchange one of the application profiles between the transceivers.
  - 1 12. The method of claim 1 further comprising generating one of the application profiles upon
  - 2 an initial occurrence of a unique set of active applications, and associating the generated
  - 3 application profile with that unique application set.
  - 1 13. The method of claim 1 further comprising locally generating, by each of the transceivers,
  - 2 at least one of the transmission parameters for one of the stored application profiles.

- 32 -

- 1      14. The method of claim 1 wherein the transceivers are preconfigured with the stored  
2                  application profiles.
- 1      15. The method of claim 1 wherein the at least one transmission parameter specified for each  
2                  application in one of the stored application profiles is at least one of a transmission data  
3                  rate, subchannels allocated for downstream and upstream transmission, a number of bits  
4                  allocated to each of the subchannels, performance margin, fine gain adjustments for each  
5                  of the subchannels, interleave depth, a minimum and a maximum QAM constellation  
6                  size, a length of a cyclic prefix, a codeword size, a framing mode, and trellis code.
- 1      16. The method of claim 1 wherein the first stored application profile characterizes a  
2                  transmission of signals associated with a Web browsing application, and the second  
3                  stored application profile characterizes concurrent transmission of signals associated with  
4                  a voice telephony application and the Web browsing application.
- 1      17. In a multicarrier modulation system including transceivers in communication with each  
2                  other over a communication channel, a method for supporting multiple applications that  
3                  are active between the transceivers, the method comprising:
  - 4                  developing a plurality of application profiles for characterizing transmission of  
5                  information over the communication channel;
  - 6                  associating each application profile with a unique set of one or more applications  
7                  that may become active between the transceivers;
  - 8                  storing the application profiles at the transceivers;
  - 9                  transmitting information over the communication channel according to a first  
10                 stored application profile that corresponds to a set of currently active applications;

- 33 -

11            retrieving, in response to a change in the set of currently active applications that  
12            are active between the transceivers, a second one of the application profiles that  
13            corresponds to the changed set of currently active applications; and  
14            transitioning to transmitting information over the communication channel  
15            according to the second application profile.

- 1        18. The method of claim 17 wherein the transitioning occurs without interrupting  
2            communication between the transceivers in order to retrain the transceivers.
- 1        19. The method of claim 17 wherein the transitioning includes retraining the transceivers to  
2            communicate according to the second stored application profile.
- 1        20. In a multicarrier modulation system including transceivers in communication with each  
2            other over a communication channel, a method for supporting a plurality of applications  
3            comprising:  
4                defining a plurality of application profiles, each application profile corresponding  
5                to a unique set of one or more applications and specifying at least one transmission  
6                parameter for each application in that unique application set for transmitting information  
7                associated with that application over the communication channel; and  
8                storing the plurality of application profiles at one of the transceivers.
- 1        21. In a multicarrier modulation system including a transceiver communicating over a  
2            communication channel, a method for supporting a plurality of applications comprising:  
3                defining a plurality of application profiles, each application profile corresponding  
4                to a unique set of one or more applications and specifying at least one transmission  
5                parameter for each application in that unique application set for transmitting information  
6                associated with that application over the communication channel;

- 34 -

7           storing the plurality of application profiles at the transceiver;  
8           transmitting information according to a first stored application profile that  
9           corresponds to a set of currently active applications;  
10          selecting, in response to a change in the set of currently active applications, a  
11          second stored application profile that corresponds to the changed set of currently active  
12          applications; and  
13          transitioning to transmitting information according to the second stored  
14          application profile without having to retrain the transceiver.

- 1       22. The method of claim 21 further comprising transmitting a message that identifies the  
2           second application profile as the application profile to use for subsequent  
3           communications.
- 1       23. The method of claim 21 further comprising receiving a message that identifies the second  
2           application profile as the application profile to use for subsequent communications.
- 1       24. In a multicarrier modulation system including a transceiver communicating over a  
2           communication channel, a method for supporting a plurality of applications comprising:  
3           defining a plurality of application profiles, each application profile corresponding  
4           to a unique set of one or more applications and specifying at least one reception  
5           parameter for each application in that unique application set for receiving information  
6           associated with that application over the communication channel;  
7           storing the plurality of application profiles at the transceiver;  
8           receiving information according to a first stored application profile that  
9           corresponds to a set of currently active applications;

- 35 -

10           selecting, in response to a change in the set of currently active applications, a  
11           second stored application profile that corresponds to the changed set of currently active  
12           applications; and

13           transitioning to transmitting information according to the second stored  
14           application profile without having to retrain the transceiver.

1     25.   The method of claim 24 further comprising transmitting a message that identifies the  
2           second application profile as the application profile to use for subsequent  
3           communications.

1     26.   The method of claim 24 further comprising receiving a message that identifies the second  
2           application profile as the application profile to use for subsequent communications.

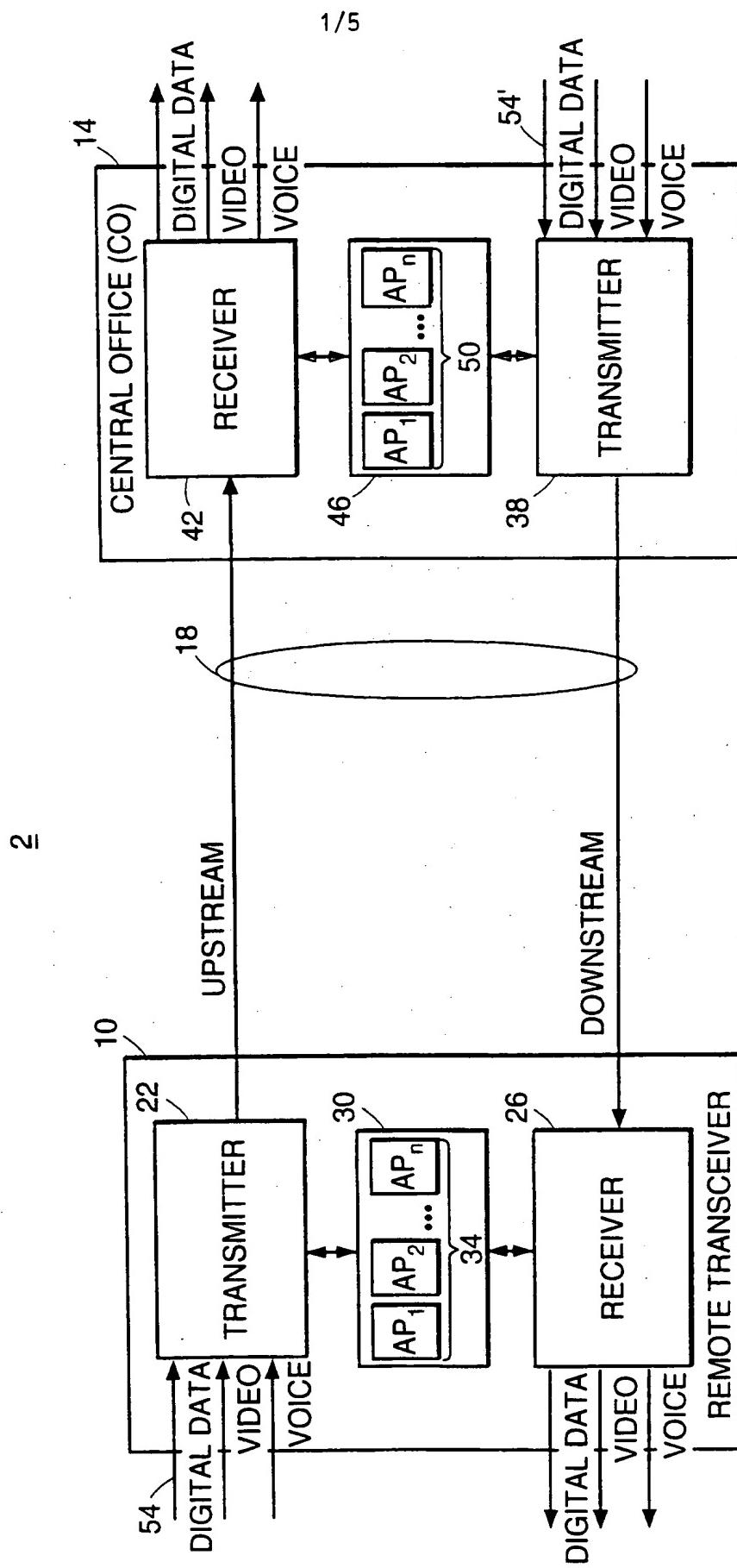


FIG. 1

SUBSTITUTE SHEET (RULE 26)

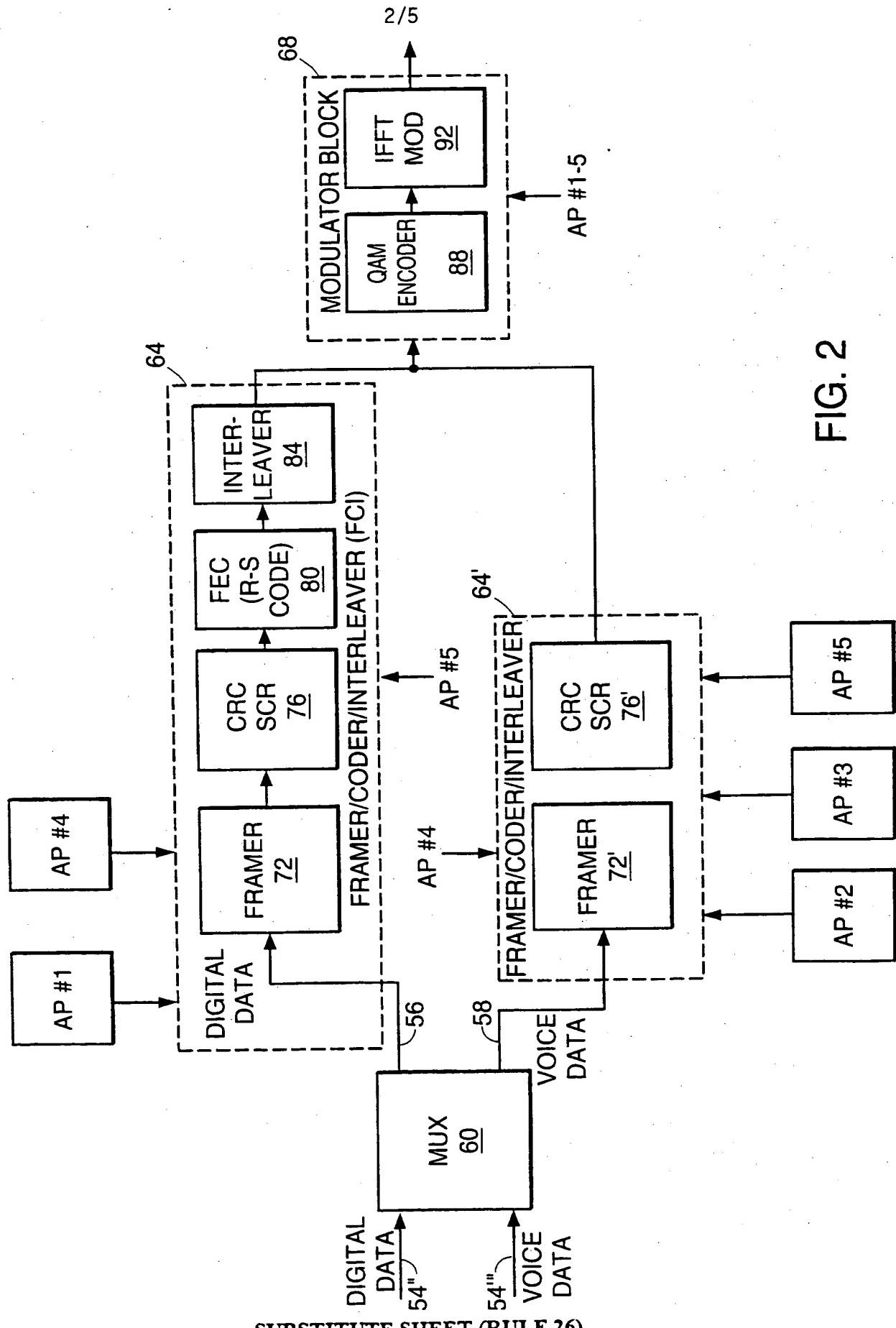


FIG. 2

SUBSTITUTE SHEET (RULE 26)

3/5

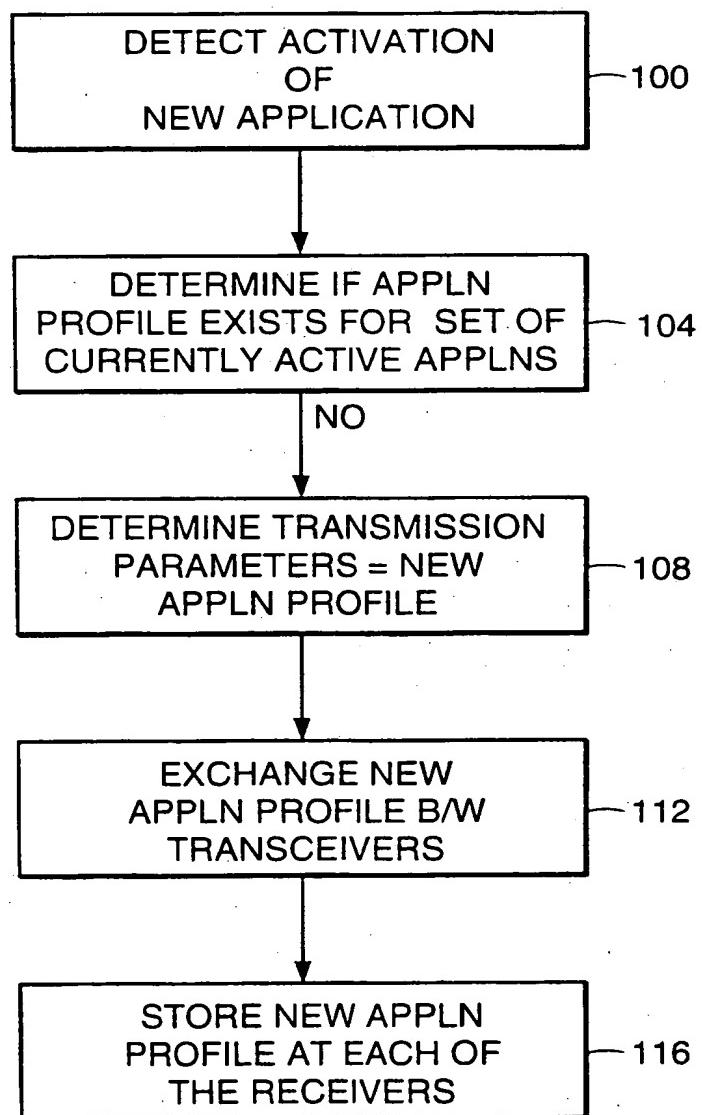


FIG. 3

4/5

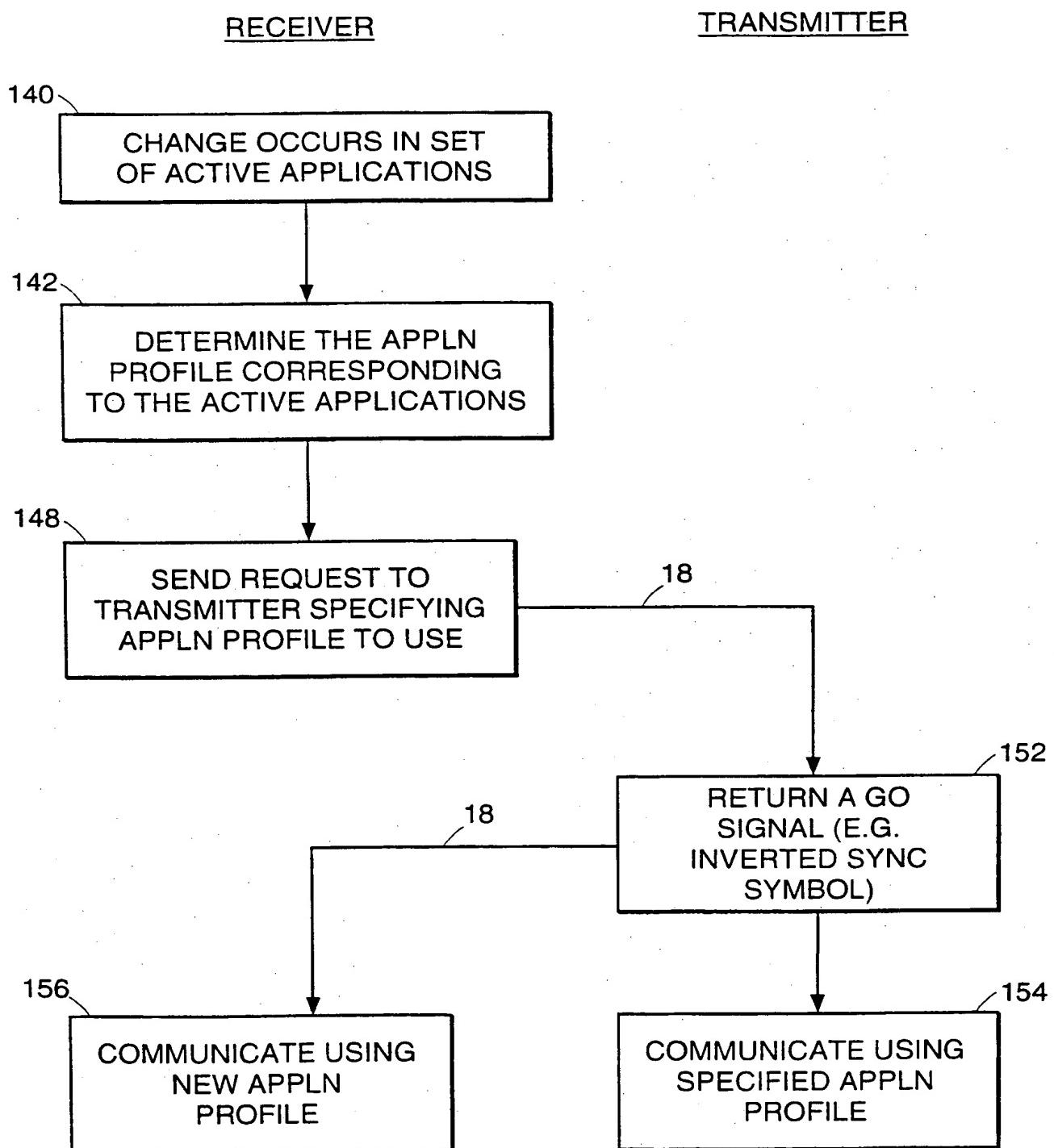


FIG. 4

5/5

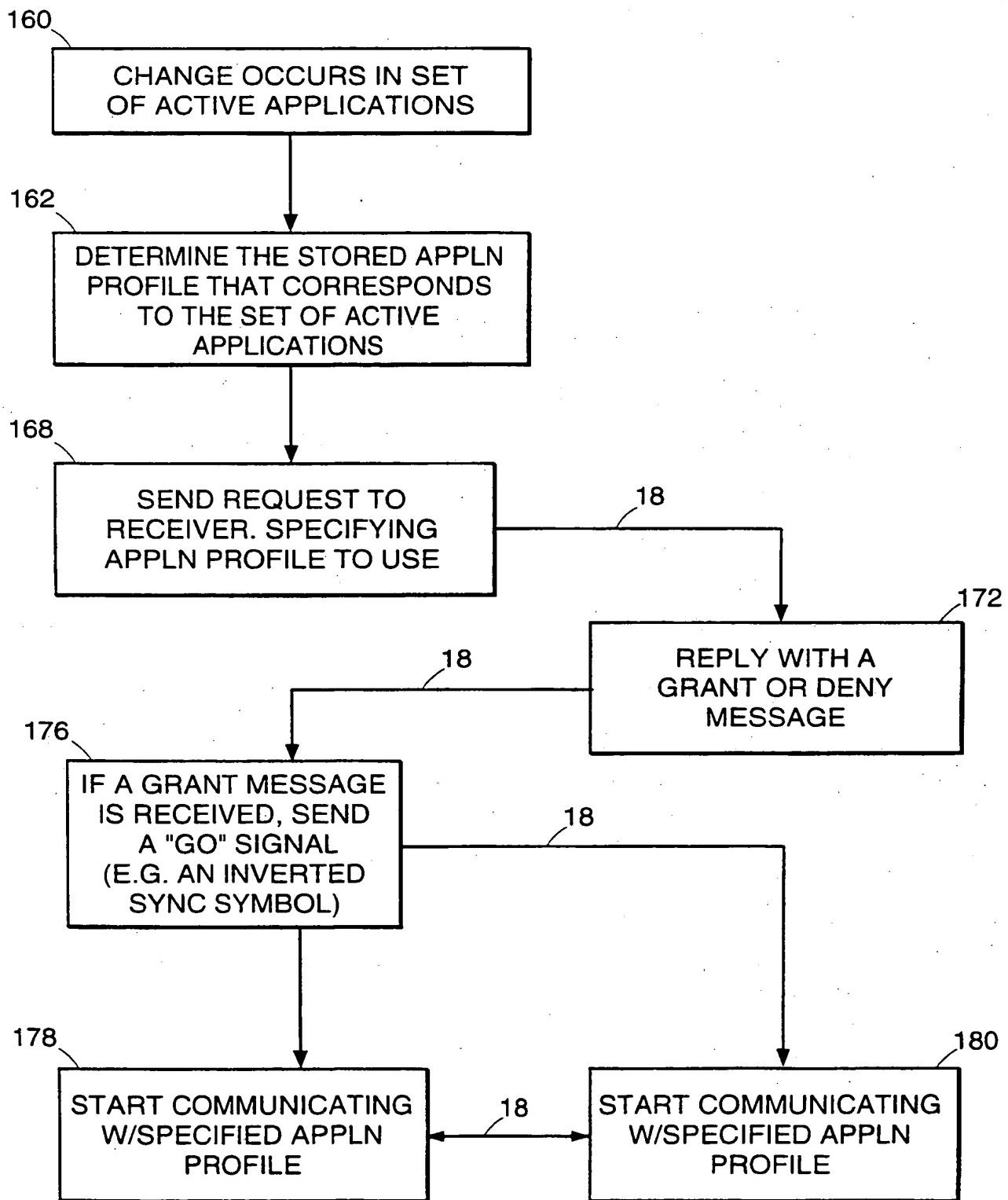
TRANSMITTERRECEIVER

FIG. 5

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/25352

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 H04L27/26

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX, IBM-TDB

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category | Citation of document with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|----------|---|-----------------------|
| X        | WO 99 20027 A (TZANNES MICHAEL A ; AWARE INC (US); GROSS RICHARD W (US); KRINSKY D)<br>22 April 1999 (1999-04-22)<br>abstract<br>page 6, line 11 - line 22<br>page 7, line 9 -page 10, line 8<br>page 15, line 25 -page 17, line 5<br>---<br>WO 97 36384 A (BOSCH GMBH ROBERT ; ALBERTY THOMAS (DE); AUER ERICH (DE))<br>2 October 1997 (1997-10-02)<br>abstract<br>page 3, line 22 -page 6, line 2<br>claim 1<br>---<br>-/-/ | 1-26                  |
| X        |   | 1-26                  |

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

\* Special categories of cited documents

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*&\* document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

18 December 2000

29/12/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
 Fax: (+31-70) 340-3016

Authorized officer

Koukourlis, S

## INTERNATIONAL SEARCH REPORT

Intell. Int'l Application No

PCT/US 00/25352

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|----------|--|-----------------------|
| A        | US 5 682 419 A (PENDLETON MATTHEW A ET AL) 28 October 1997 (1997-10-28)<br>column 24, line 8 -column 27, line 11;<br>figure 23<br>claims<br>----   | 1-26                  |
| A        | EP 0 905 948 A (MOTOROLA INC)<br>31 March 1999 (1999-03-31)<br>abstract<br>paragraph '0014! - paragraph '0019!<br>----   | 1-26                  |
| A        | EP 0 869 647 A (LUCENT TECHNOLOGIES INC)<br>7 October 1998 (1998-10-07)<br>page 2, line 25 - line 54<br>page 3, line 15 -page 4, line 30<br>----   | 1-26                  |
| P,X      | WO 00 13387 A (ADVANCED MICRO DEVICES INC)<br>9 March 2000 (2000-03-09)<br>page 6, line 20 -page 7, line 4<br>page 7, line 28 -page 8, line 19<br>page 9, line 1 - line 33; figure 13<br>----- | 1-26                  |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Internatinal Application No

PCT/US 00/25352

| Patent document cited in search report | Publication date | Patent family member(s)                            |   | Publication date   |
|--|------------------|--|---|--|
| WO 9920027                             | A<br>22-04-1999  | AU<br>EP   | 1077699 A<br>1021901 A  | 03-05-1999<br>26-07-2000   |
| WO 9736384                             | A<br>02-10-1997  | DE<br>AU<br>AU<br>BR<br>CN<br>DE<br>EP<br>ES<br>FI | 19635533 A<br>707683 B<br>2222397 A<br>9612582 A<br>1209236 A<br>59604632 D<br>0890227 A<br>2144285 T<br>981617 A | 30-10-1997<br>15-07-1999<br>17-10-1997<br>20-07-1999<br>24-02-1999<br>13-04-2000<br>13-01-1999<br>01-06-2000<br>15-07-1998 |
| US 5682419                             | A<br>28-10-1997  |  | NONE  |  |
| EP 0905948                             | A<br>31-03-1999  | US   | 6130882 A   | 10-10-2000   |
| EP 0869647                             | A<br>07-10-1998  | JP   | 10303849 A  | 13-11-1998   |
| WO 0013387                             | A<br>09-03-2000  |  | NONE  |  |